Determining the real impact of speed limit enforcement cameras in the UK

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Abstract

The first UK fixed speed camera was installed in 1992; by 2005 there were 4000 and a peak of 6000. Most fixed cameras are painted yellow, and have markings on the road which provide a secondary speed check. Most sites were selected based on 4 or more KSI crashes over a recent three-year period.

Research papers since the late 1990's have estimated the effect of speed cameras on crash rates, with KSI reductions ranging from 65% in early reports to 22% in Allsop (2013) report. Other researchers in the UK and elsewhere considered these claims to be excessive given that police analyses of contributory factors from 2005 consistently show that only ~8% of KSI crashes identify exceeding the speed limit as a "likely" or "possible" contributory factor – and even then not necessarily as the primary cause.

Idris Francis decided to undertake a thorough investigation. He obtained details of some 5 million injury crashes from 1987 to 2011 from the UK Data Archive and obtained from police or UK Safety Camera Partnerships the precise location and installation month for cameras in London, Wales, Scotland and 19 other police areas in England, covering more than 50% of all such UK collisions.

The crash histories of camera sites were then compared to areas that did not receive cameras. With the benefit of very large volumes of (monthly, not annual) data that minimise random effects it became clear that the benefits long claimed simply do not exist and were instead the result of seriously flawed analysis of insufficient and imprecise data, coupled with astonishing willingness to believe impossibilities.

It should also be noted that if cameras reduced crashes, those effects would be bound to start at the time of installation and reach a maximum within a matter of months as the proportion of drivers aware of the cameras reaches a maximum – and not continue to provide increasing benefit year after year. That characteristic dip at just the right time does indeed exist, but not remotely to the extent long claimed, nor do those effects persist.

Note: The term crash has been used throughout except where it is a title – for example Stats 19 Accident database.

Introduction – safe driving and the role of speed, speed limits and speed cameras

Safe driving/ riding requires an alert driver/ rider, not impaired by alcohol, illicit drugs, prescribed drugs, a medical condition or fatigue, using occupant protection equipment, and choosing an appropriate speed and appropriate clearance distance to allow them to stop or swerve in time to avoid a collision. Studies show distraction is a factor in around 65% of near crashes and 78% of crashes (Klauer et al 2006). For Australian fatal crashes, alcohol or drugs are factor**s** in around 30%, failure to wear seat belts or helmets in around 20%, fatigue in around 18%, driving below the speed limit but at an inappropriate speed in around 17%, and exceeding the speed limit in around 13%.

Speed has been recognised as a factor in crashes from long before the "Speed kills" campaigns in the 1970's, and speed limits and tolerances have in some jurisdictions increasing**ly** been used to limit vehicle speeds. Since the early 1970's there has been a progressive increase in speed detection/speed enforcement equipment - handheld radar and laser speed detectors, mobile speed cameras, fixed red light and speed cameras, and recently average speed cameras.

The first UK fixed speed camera was installed in 1992; by 2005 there were 4,000, and at the peak there were around 6,000. Most UK fixed cameras are painted yellow, and have markings on the road which provide a secondary speed check based on two images 0.5 seconds apart. Most sites were selected for 4 or more KSI crashes over **recent** three-year periods, though long delays between site selection and installation can cause analysts problems in research.

Contributory factor "exceeding the speed limit" in KSI crashes

UK police have a menu of 77 contributory factors to be applied to reported crashes – on average there are 1.95 contributory factors for fatal crashes, and 1.75 contributory factors for other casualty crashes. The contributory factors include *Exceeding the speed limit* and *Travelling too fast for the conditions.* These contributory factors are aggregated against fatal, serious and slight crashes and published in the Department for Transport statistics Table RAS50001. Data from those tables for the years 2010 to 2013 have been included in the table below, with the sum of the fatal and serious crash contributory factors being added together to give a figure for KSI crashes.

Table 1. Table RAS50001: Contributory factors: Reported crashes by severity: www.dft.gov.uk/statistics

Year	**2010**		**2011**		**2012**		**2013**	
	Exceed limit	Too fast	Exceed limit	Too fast	Exceed limit	Too fast	Exceed limit	Too fast
Fatal	221	215	213	207	173	167	216	191
Total	1620		1663		1497		1486	
%	13.6%	13.3%	12.8%	12.5%	11.6%	11.2%	14.5%	13.9%
Serious	1179	1565	1095	1470	1041	1498	1093	1326
Total	18043		18391		18196		16974	
%	6.5%	8.7%	6.0%	8.0%	5.7%	8.2%	6.4%	7.8%
KSI	1400	1780	1308	1677	1214	1661	1309	1517
Total	19663		20054		19693		18460	
%	7.1%	9.1%	6.5%	8.4%	6.2%	8.4%	7.1%	7.8%

Note that despite the high emphasis on reducing speeding, the exceeding the speed limit rates have hardly changed.

As shown, exceeding the speed limit is a contributory factor in 6.2% to 7.1% of KSI crashes. It would be wrong to assume however that cameras could ever bring about similar reductions because even if speeding were fully eliminated – which it is not – many of those crashes may still happen due to other causal factors.

Note that exceeding the speed limit was stated as a contributory factor in 3.7% to 4.4% of slight injury crashes over the period.

The USA FARS crash database also has a speeding related data entry variable. It covers "Racing" "Exceeded Speed Limit" and "Too Fast for Conditions." Council (2010) contains data for North Carolina and Ohio crashes shown below. Note severity categories do not allow a direct determination of the % of KSI crashes where exceeding the speed limit was a factor.

Table 2: Frequency and number/percentage of Speed Related crashes regarding crash severity in North Carolina 2002-2004

Severity	Over limit		Too fast		Total speed		Not speed		Total
	No	%	No	%	No	%	No	%	No
Fatal injury	733	24.0%	404	13.2%	1137	37.3%	1913	62.7%	3050
Disabling	835	13.8%	1076	17.7%	1911	31.5%	4156	68.5%	6067
Evident injury	2916	7.7%	6427	17.0%	9343	24.7%	28536	75.3%	37879
Totals	4484	9.5%	7907		12391		34605		46996

As shown in Table 2, 9.5% of all casualty crashes involved "Exceeding the speed limit."

Table 3: Frequency and number/percentage of Speed Related crashes regarding crash severity in Ohio 2003-2005

Severity	Over limit		Too fast		Total speed		Not speed		Total
	No	%	No	%	No	%	No	%	No
Fatal injury	398	20.8%	156	8.2%	554	29.0%	1355	71.0%	1909
Incapacitating injury	1720	15.0%	753	6.6%	2473	21.6%	8994	78.4%	11467
Non-incapacitating injury	5255	11.0%	3668	7.7%	8923	18.6%	38995	81.4%	47918
Totals	7373	12.0%	4577		11950		49344		61294

As shown in Table 3, 12.0% of all casualty crashes involved "Exceeding the speed limit"
These percentages are higher than the UK percentages but still much lower than many of the claimed impacts of speed cameras on casualty crashes.

Evaluations of the impact of speed cameras on road trauma – Australia references

An evaluation of Victoria, Australia's covert mobile speed camera program – Cameron (1992) - found a reduction in casualty crashes across Victoria of ~ 20%; in Melbourne of ~22%; in rural Victoria of ~ 18%; and on Melbourne's arterial roads a reduction of ~ 33%.

And in a more general review of speed camera programs – Cameron (2006) - referenced reductions in Table 2 as detailed below:

- Fixed and/or known/signed installations –:
  - In Great Britain — Local reductions of 65% in serious casualty crashes for fixed cameras and 28% for mobile cameras;
  - In New Zealand – Local reduction of 28% in serious casualty crashes for mobile cameras, and a general reduction of 13%; and
  - In Queensland Australia - Local reduction of 35% in casualty crashes, and a general reduction of 26%;

- Unsigned sites or zones – in Victoria Australia:
  - General reductions of 21% for Victoria & 32% for Melbourne with mobile cameras; and
  - a 21% reduction in serious casualties per crash for mobile cameras in Melbourne.

Evaluation of the impact of speed cameras on road trauma – formal UK research

In the**ir** executive summary PA Consulting (2005) claimed that after allowing for long-term trend there was a 22% reduction in personal injury collisions (PIC)at camera sites, a 42% reduction in persons killed or seriously injured, and a 32% reduction in persons killed. Appendix H of the report noted that after using the empirical Bayes analysis to try to deal with regression to the mean (RTTM) the reduction in personal injury collisions at camera sites was 16% and the reduction in KSI collisions was 10%.

In Allsop (2010) a number of approaches were taken to estimating the effect of speed cameras on PIC and KSI crashes. These included adjustments for trend, the use of reductions in average speeds at camera sites plus Nilsson / Elvik power relationships to predict reductions, and the use of empirical Bayes analysis. All of these can now be shown to be seriously flawed.

And in Table 7 of that report it was estimated that overall the reductions were as shown below.

Table 4: Allsop (2010) estimated % reductions in PIC and KSI crashes

Type of site	Percentage reduction - PIC	Percentage reduction - KSI
Fixed urban	between 20% and 25%	between 35% and 40%
Fixed rural	between 20% and 30%	between 30% and 50%
Mobile urban	between 15% and 20%	between 15% and 30%
Mobile rural	between 10% and 15%	between 15% and 30%

In Allsop (2013a) the executive summary references a 25% reduction in PIC after establishment of cameras, and a 38% reduction in KSI crashes.

In Allsop (2013b), the executive summary references a 22% reduction in PIC after establishment of cameras, and a 32% reduction in KSI crashes.

All these claims much exceeded the contribution of speeding to crash causation in the first place as noted previously, even though speeding had far from been eliminated. This was primarily because of analysts' abject failure to understand and deal properly with trend and RTTM.

Concerns about the formal UK speed camera research

The principal concerns are the large differences between the *exceeding the speed limit* contributory factor reported by police – 11.6% to 14.5% for fatal crashes; 6.2% to 7.1% for serious crashes and 3.7% to 4.4% for slight injury crashes – and the reported reductions in deaths and casualty crashes at camera sites. Note that the figures include both possible and very likely contributory factors. This led to a number of individuals undertaking their own research into the effectiveness of speed cameras. **(Note – the above para arguably makes some of my earlier changes unnecessary. Idris)**

An alternate approach to researching speed camera effectiveness

This research is based on the hypothesis that:

- Cameras cannot have an impact until they are installed;
- Any impact commences immediately after installation and rapidly reaches a maximum;
- As a result the month of installation, and monthly crash data is required for camera sites and other similar sites where cameras were not installed; and
- By comparing trends in numbers of crashes at camera sites, and trends at other similar sites from a period well before installation to well afterwards any step reduction in crashes at camera sites would be easily identified.

Research by David Finney, an electronics engineer

Dave Finney's research relates to Thames Valley speed cameras and is available at http://www.speedcamerareport.co.uk. The data used by David was provided and verified by the Thames Valley Safer Roads Partnership (TVSRP), the organisation responsible for the cameras. In the process of developing a robust speed camera assessment method David recognised a number of issues and developed ways to work around them. For example, to deal with any trend effects (the influence of other factors on crash numbers, his analysis used the proportion of crashes at speed camera sites compared to the total number of crashes in the Thames Valley area. And to obtain meaningful results, crash histories for mobile camera sites, and for fixed camera sites were separately aggregated.

He also determined that there are four periods (others had used as few as two) relating to site data:

- the period prior to the site selection period (pre-SSP);
- the site selection period (SSP) –most sites have been chosen based on at least four KSI crashes over a recent three-year period. Due to chance variation in site KSI numbers, the totals are abnormally high and these are bound to return to normal the moment selection ends (RTTM);
- the period after the SSP but before the cameras were commissioned (ASBiC) when numbers have already returned to normal; and
- finally, the period during which the speed cameras were operating.

Often, only limited official data is to hand to allow–identification of these four periods and accordingly it is necessary to analyse site data to identify the SSP period. This is a particular problem with fixed speed cameras because the time between site selection and commissioning varies greatly due to planning and logistical problems. Mobile speed camera sites become operational as soon as the mobile speed camera vehicles are deployed, but that does not mean there are no delays.

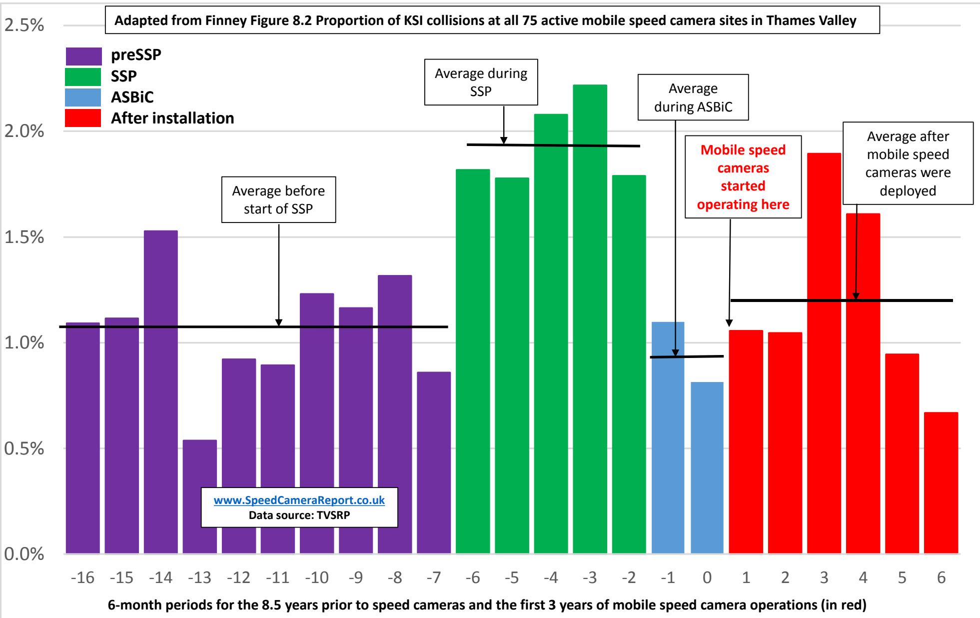

Figure 1. Adapted from Finney figure 8.2 - proportion of all KSI collisions at all 75 active mobile speed camera sites in the Thames Valley

As shown in Figure 1 in the pre-SSP period on average 1.07% of all Thames Valley KSI collisions occurred at these mobile speed camera sites. This percentage rose to 1.94% in the SSP period, dropped back to 0.96% in the ASBiC period, and rose to 1.20% over the 3 years after the mobile speed cameras started operating. Finney recognised that abnormal selection period data should never have been used as a baseline reference and accordingly sought other ways of determining normal levels..

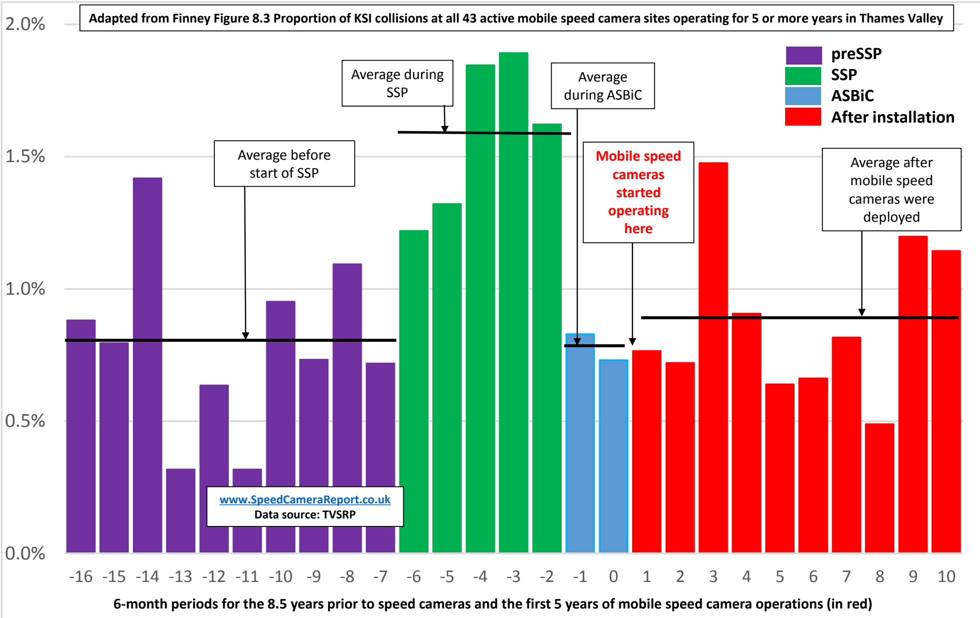

Figure 2. ***Adapted from Finney figure 8.3 - proportion of all KSI collisions at all 43 active mobile speed camera sites operating for five or more years in the Thames Valley***

As shown in Figure 2 will in the pre-SSP period on average 0.79% of all Thames Valley KSI collisions occurred at these mobile speed camera sites. This percentage rose to 1.58% in the SSP period, dropped back to 0.78% in the ASBiC period, and rose to 0.88% over the 5 years after the mobile speed cameras started operating.

In both cases the pre-SSP period figures and the ASBiC figures are similar as expected. And as expected the crash rate in the SSP period is significantly higher.

However in contrast to earlier claims, post commissioning crash rates are in fact higher than the prior level. Prima facie this confirms that cameras had a negative impact on reducing crashes and road trauma.

There were a total of 212 fixed speed camera sites in the Thames Valley. For many sites Finney was unable to source crash data from well before the commissioning of the cameras. As a result he was unable to identify a pre-SSP period. In order to get reliable pre-SSP data, data for the 74 most recently installed fixed speed cameras was separately analysed as shown in figure 3.

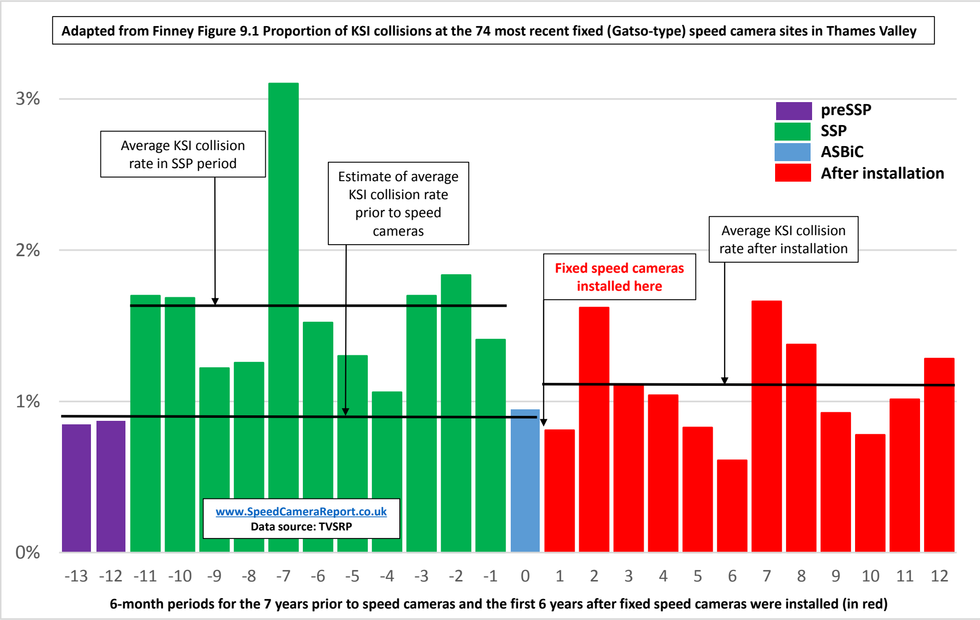

Figure 3. Adapted from Finney figure 9.1 - proportion of KSI collisions at all 74 most recent fixed (Gatso – type) speed camera sites in the Thames Valley

In the pre-SSP period and the ASBiC period 0.89% of all Thames Valley KSI collisions occurred at these fixed speed camera sites. This percentage rose to 1.62% in the SSP period, and was 1.09% over the 6 years after the fixed speed cameras were installed.

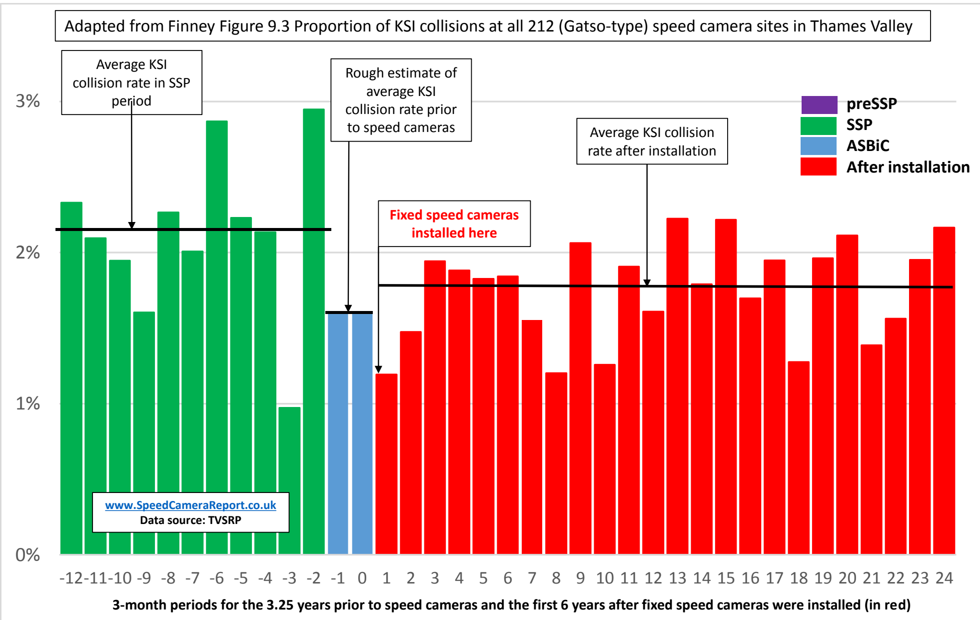

Figure 4. Adapted from Finney figure 9.3 - proportion of KSI collisions at all 212 fixed (Gatso – type) speed camera sites in the Thames Valley

As shown in Figure 4 there is no identified pre-SSP period. However the ASBiC period, being free of selection bias, is arguably a better indication of "normal" than levels some years before that have been affected by trend effects**.** On average 1.59 % of all Thames Valley KSI collisions occurred at these fixed speed camera sites during the ASBiC period. In the SSP period the rate was 2.13%, and in the after installation period the rate was 1.75%.

Again the post-commissioning crash rates were higher than the ASBiC rate.

Research by Idris Francis

In the early 2000's statisticians claimed that speed cameras in the UK were achieving tremendous road safety gains with reductions in crashes of the order of 40% to 60%. And even before the DfT causal factor analysis was first published in 2006, many independent observers, mostly engineers more used to working with data than probability theory, refused to believe that such large reductions could ever be achieved with such modest reductions in speeds.

In order to determine the real effectiveness of speed cameras Francis decided to obtain a great deal more than others had used, including precise locations and dates. He also obtained the precise locations and installation dates of as many cameras as possible. Currently that includes details for 22 out of 43 police areas including the three largest areas. His aim was to compare the crash histories of camera sites with those where there were no cameras, on a very large scale.

Issues – form and quality of data

While some official site data has been published it is difficult or tedious to collate especially when provided as separate pdf or Excel sheets for each camera site. Stats19 Police data on the other hand is published annually in a consistent format so that re-formatting into convenient databases is simple.

Methodology

Idris obtained some 5 million Stats19 Accident and related casualty records from 1987 to 2011 from the UK Data Archive, including the 6 digit Easting and Northing grid references and the date and speed limit of every crash. It was then entered into a Silicon Office relational database software which he had used for 30years.

The official data contained many errors and omissions, including absurd location codes showing crashes miles out to sea! In order to address this issue the northing, easting, southing, and westing coordinates of the extremities of each police area were identified and where discrepancies appeared each record was reviewed. More recently, the Department of Transport issued corrected location data from 2000 onwards.

Stats19 Data

The police records of every reported injury road crash routinely published by the DfT do not include all of the details needed for speed camera analysis, but the csv files available to researchers from the UK Data Archive include all recorded Stats19 information (other than causation assessment, considered too sensitive for inclusion). However there are restrictions prohibiting copying the data to others unless in summary or redacted form.

Annual Crash, Casualty and Other Data used in this analysis

Stats19 uses one crash file and one casualty file for each year, each casualty record being linked to the relevant crash by unique codes. For the most part this analysis uses crashes not casualties. However the comparative results are much the same for both.

Separate Excel files for Slight Injury and Fatal/ Serious injuries show as a minimum:

- Police Code 9 digits (2 being Force code, the remaining 7 are normally of no significance other than for identifying particular crashes;
- Limit Relevant Speed Limit;
- EW Ordnance Survey Easting Grid Reference, 6 digits identifying the East/West location within 1 metre;

- NS Ordnance Survey Northing Grid Reference, 6 digits identifying the North/South location within 1 metre;
- WHEN Numerical code for date of crash, e.g. Year *12 + month;
- DIST Initially blank field to hold distance from nearest camera; and
- DIFF Initially blank field to hold the difference in months

As might be expected, crash and casualty trends are very similar so the analysis only uses crash data. This cuts down the data handling requirement as only the collision files are needed.

Camera Site Data (where available)

These files, one per Partnership area, generally provide the following data

- Police Code 2 digits
- EC Ordnance Survey Grid Reference, 6 digits identifying the East/West camera location.
- NC Ordnance Survey Grid Reference, 6 digits identifying the North/South camera location within 1 metre
- WHEN Numerical code for installation month of camera, e.g. Year *12 + month;

To date, speed camera data for 22 police areas has been obtained and analysed. In some cases it was obtained despite the apparent reluctance of Partnerships to provide it, while others claimed not to hold it. Given that the Stats19 data is available to them, and they must know where and when their sites were installed, the reality is that the data is available. They have not bothered to collate it to date.

Distances between Crashes and Casualties in Relation to Camera Sites.

From this point on, the raw crash/casualty data was split up into separate files for each police area. Then, given the co-ordinates of crashes and camera sites, within one area, Pythogoras Theorem can find the nearest camera to each crash and enter that distance into the DIST field of each crash record.

It was found that indexing camera locations by the first 3 digits of the Easting codes greatly speeds up the processing.

Months between Crashes and Casualties in Relation to Camera Site Installations.

Similarly, comparing the WHEN codes of the accident and camera installation, the DIFF field of the accident record can be entered and stored.

Processing

The resulting data may be processed to provide the following:

- A single Excel sheet showing 1987-2011 Stats19 fatal and serious crash (FSC) data aggregated by **police area, year, distance from camera site if within 1km, speed limit, and delay in months between crash and camera installation**. This allows large numbers of graphs to be drawn very quickly.
- A similar sheet covers Slight Injury Collisions.
- 1987-2011 Stats19 FSC data for all police areas by area and month
- As above for each camera in 22 police areas for any desired site radius.

Analysis

Analysis only requires the application of simple arithmetic to FSC crashes near any one of 3,400 camera positions in the 22 police areas for which data is currently available.

Critically, with this method there is no need for estimates, probability theories, mathematical models, or any other manipulation of the data in order to make comparisons between sites where cameras have been installed, and similar sites where cameras have not been installed.

And if a camera or group of cameras have any beneficial effect, it will appear as a quite sudden reduction in accidents their reach camera from the month of installation onwards.

In the first two of the following graphs, to make comparison easy, the numbers of non-camera site KSI have been scaled down to equal the number of KSI at camera sites in 1991. The first method (Fig.5) compares FSC rates near cameras with rates elsewhere in the same police area(s) Site selection based on high numbers of crashes causes previously common trends to diverge and after selection this effect ends, leading to convergence. Once past that transient effect, camera benefit, if it existed, would be confirmed by crash numbers falling further than non-site data. It is clear that they do not.

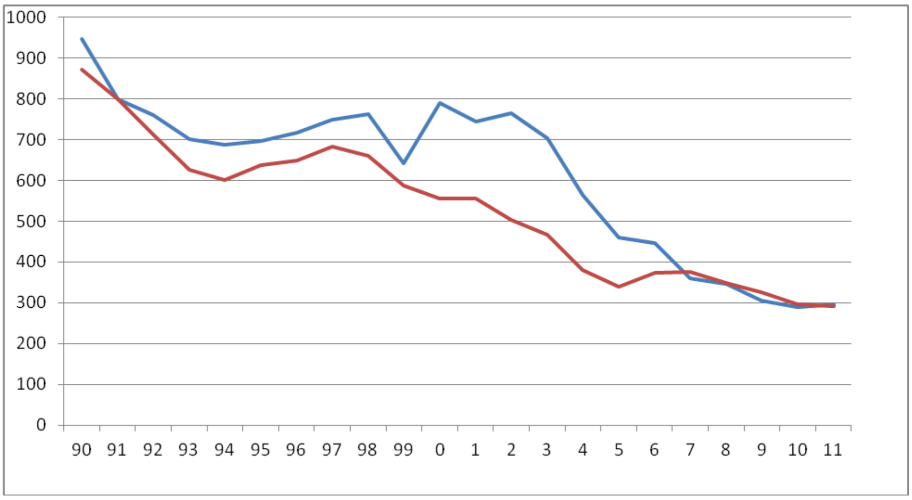

Figure 5. Method 1 – London camera site KSI in blue (475 Sites -last one installed in 2008) versus non-camera site KSI crashes in red

After the separation in the two graphs caused by camera sites being selected for high crash rates, the two graphs converge from 2007 onwards – there is no difference in the trends in the number of crashes, the scaled trendlines overlapping in 1991, and then again overlapping from 2007 through to 2011.

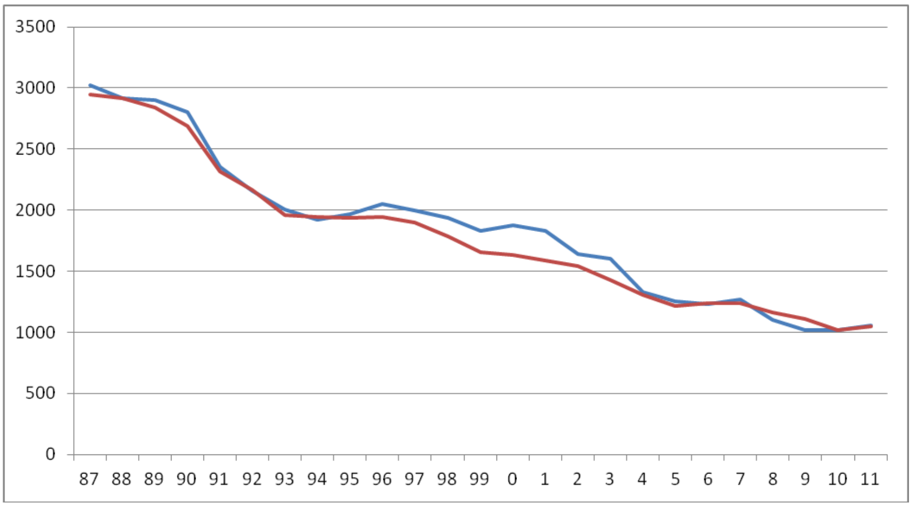

Figure 6. Method 1 – KSI in England and Wales within 500m of camera locations on 30mph roads - camera site KSI crashes in blue versus non-camera site KSI crashes in red

There is no discernible difference in the scaled trendlines in numbers of crashes in the two graphs either side of the period in which most cameras were installed - around 1995 to 2004. This graph of sites on 30 mph roads represents about 60% of all camera sites identified in the 32 police areas.

The above two graphs and some others use Transport for London data published in July 2014. Unfortunately London is one of only 10 or 11 areas to have published sensibly usable data, and the only where the volume of data is in any case large enough to allow accurate analysis. For that reason the second method used in this analysis is based in circular sites centred on cameras, for these reasons:

- It bypasses the failure of so many partnerships to publish usable data and so thereby allows a much larger scale analysis which is inherently more accurate.

- It allows monitoring of the distances over which camera effects extend, which partnerships are unable to do with their fixed and necessarily subjective site boundaries.

Doubtless some who would prefer not to believe the results provided, will claim that they are invalid because they do not conform to a view of where site boundaries should be drawn. Research known to the authors tends to show that the effect of speed cameras on speed behaviour typically extends around 700 m either side of the camera. For that reason boundaries have been chosen up to 1000 m from the camera location.

Also, if crash numbers appear to fall within narrowly defined boundaries, they should also fall within wider circular boundaries. If they do not, that can only be because the cameras are merely shifting crashes from one place to another (by for example by causing drivers to divert) rather than reducing them

It brings consistency to the results, as opposed to the variations arising from the different ways in which site boundaries are determined by different partnerships.

This second method uses monthly data for cameras installed between 1994 and 2008, adjusted relative to camera installation month (in this case set as month 85) to identify and quantify any reductions in KSI following installation..

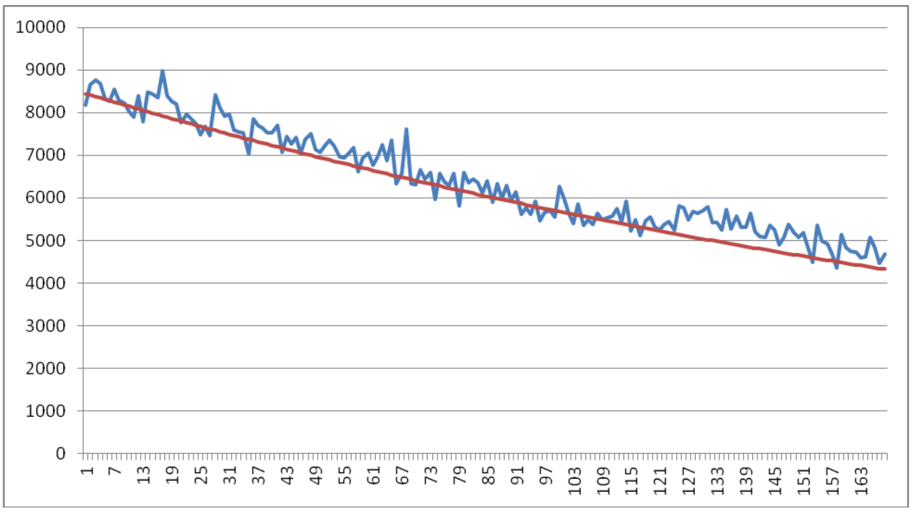

Figure 7. Method 2 –FSC within 500 m of cameras for 22 Police Areas–with installation adjusted to month 85. Average Trend in red > 1km from cameras, * 0.996/ per month

There is no identifiable drop in KSI within 1km of the cameras after installation in month 85.

Hundreds of graphs can be drawn from the each single Excel sheet of crash data, for different combinations of police area, speed limit, radius from camera and camera type. Every graph drawn to date shows the same results – minimal and short-lived reductions close to cameras and significant increases further away. The same applies to Slight Injury Collisions as to FSC.

Conclusion

Previous research suggests that speed cameras reduce crashes by 22% - 65%. However UK and US contributory factor data shows that *exceeding the speed limit* is only a factor in around 11% to 24% of fatal crashes; 6% to 10% of KSI crashes and 4% to 5% of slight injury crashes. And logic suggests that significantly lower figures than these should be the limit to the effectiveness of speed cameras.

In an effort to get around this apparent contradiction both Finney and Francis used unadjusted data (no statistical tools such as the empirical Bayes method were used) to directly determine the impact of speed cameras on crashes. Both their analyses showed that speed cameras have no significant impact on road trauma.

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